REMARKS

Claim 4 was previously pending. By this paper, claim 4 has been amended, and new claims 5-6 have been added. As a result, claims 4-6 are pending, of which claims 4 and 6 are independent. No new matter has been introduced in the claim amendments.

In the Specification

Applicants amend the specification including the abstract to correct grammatical and idiomatic errors, and to conform to accepted U.S. practice. No new matter is added by these amendments.

In the Claims

Applicants amended claim 4 solely for clarity and to conform to accepted U.S. practice. Applicants also introduced new claims 5-6. Both the amendments to claim 4 and the new claims 5-6 are supported by the originally-filed specification, and do not introduce any new matter.

Rejections under 35 U.S.C. § 103

The Office Action rejected claim 4 under 35 USC § 103 as being unpatentable over either of Neutjens (EP 0507411) or Dunbar (US 6,383,314) in view of Thompson (US 4,151,013). Applicants respectfully traverse this rejection with the following remarks.

Neutjens and Thompson

With respect to Neutjens and Thompson, the Office Action alleges that Neutjens teaches a rolling process that subjects a semi-finished product to at least one intermediate soft annealing between two cold rolling stages and a final annealing, both in a batch furnace, and that the "flattening" described in Neutjens is stretch-forming. *See* Office Action pages 4 and 7. The Office Action further alleges that Thompson discloses stretch-

forming the semi-finished product by 0.1 to 0.5% after the final soft annealing, and that it would have been obvious to modify the process of Neutjens by stretching a cold rolled sheet by about 0.5% to achieve Neutjens' goal of "flattening the sheet." *See id.* at 11.

Applicants respectfully disagree. The invention of claim 4 is not obvious, at least, because the combination of the teachings Neutjens and Thompson proposed by the Office Action is improper. The Office Action failed to consider each of Neutjens and Thompson "in its entirety, i.e., as a <u>whole</u>, including portions that would lead away from the claimed invention," as required by MPEP § 2141.02 (VI). When each reference is viewed as a whole, it is clear that the particular combination of the teachings of Neutjens and Thompson proposed by the Office Action is improper because Neutjens and Thompson teach away from the combination. *See id.* at § 2145 (X)(D)(2). Further, because the particular combination of the teachings of Neutjens and Thompson proposed by the Office Action would change the principle of operation of the prior art references being combined, the teachings of the references are not sufficient to render claim 4 *prima fascia* obvious. *See id.* at § 2143.01 (VI).

For example, both Neutjens and Thompson teach away from performing intermediate and final annealing in a batch furnace, as required by amended independent claim 4. The Office Action notes that Neutjens discloses annealing in a batch furnace, but ignores the teaching of Neutjens as a whole. Neutjens is directed to a method of manufacturing a an aluminum sheet by performing recrystallization annealing "in a <u>continuous annealing furnace</u> with a heating rate of over 50 °C/s, followed by quenching." Neutjens, Abstract; *see also* page 2, lines 55-57 (emphasis added). Neutjens presents samples A and B, which were annealed in a batch furnace, as unsuitable. *See id*. at page 3, lines 50-55; page 4, lines 37-38 and 41-44. Neutjens notes that deformation of sample A could cause flow lines and that sample B had an undesirable large grain size of over 50 microns and a less smooth surface than that of samples C and D, which were annealed in an continuous annealing furnace. *See id*. at page 3, lines 50-55; page 4, lines 37-38 and 41-44.) Thus, Neutjens as a whole expressly teaches away from using a batch furnace for annealing.

The Office Action also fails to account for the overall teaching of Thompson that annealing should be performed in a continuous annealing furnace, not a batch furnace. Thompson is directed to a process that employs continuous annealing and controlled quenching. *See* Thompson at col. 5, lines 4-7, 32-45, 56-65. Thomson teaches substantially recrystallizing a sheet during a very brief final anneal (e.g., one to two minutes) that is followed by quenching the sheet at a specific quench rate. *See id.* at col. 4, lines 45-48. Such a brief anneal cannot be performed with a conventional batch furnace, but instead requires a continuous annealing furnace. *See id.* at col. 5, lines 3-7, 13-21 (disclosing preferred type of continuous annealing system).

Thus, when the teachings of the references are correctly considered as a whole, it is clear that both Neutjens and Thompson teach away from a method that employs a batch furnace for intermediate and final annealing, as is required by claim 4.

As another example, the Office Action's proposed combination of the teachings of Neutjens and Thompson, including limiting the degree of deformation due to the second (final) cold rolling pass to not more than 30%, ignores the teaching of Thompson that requires a deformation of at least 40% in final cold rolling pass. Thompson notes "[i]n cold rolling the sheet to its finished gauge, the reduction in thickness should be at least about 40%, and will often be as much as about 60 to 80 %." Thompson at col. 4, lines 48-52. In one example relied upon by the Office Action, Thompson describes final cold rolling to "a degree of deformation of about 52.9 %." *See* Office Action at page 6. Thus, the combination proposed by the Office Action, which would include limiting deformation from second cold rolling to not more than 30%, directly contradicts the teaching of Thompson.

Further, the combination proposed by the Office Action changes the principle of operation underlying both Thompson and Neutjens. The method of Applicant's claim 4 causes as much recrystallization as possible during an intermediate soft anneal and little recrystallization during a final anneal. *See* English Translation of Application, page 3, last paragraph. Applicants' claimed methods employ a first cold rolling pass that causes a high degree of deformation, which reduces the recrystallization temperature of the product. *Id.*

The reduction in the recrystallization temperature of the product permits the product to recrystallize as much as possible during an intermediate anneal. *Id.* Applicants' claimed method limits the deformation in the second cold rolling pass to less than 30% to reduce a number surface defects being incorporated into the product, allowing the product to maintain a fine grain size through the final anneal. *Id.* from bottom of page 3 to top of page 4.

In contrast, Thompson teaches the principle of employing controlled recrystallization solely in the final anneal to reliably create a product that resists the formation of flow. *See* Thompson at col. 4, lines 45-48. Thompson directly criticizes methods employing the principle of primarily recrystallizing in an intermediate anneal followed by a final anneal with little recrystallization (a final non-recrystallizing anneal), as occurs in Applicant's claimed methods. In the background section, Thompson states that a final non-recrystallizing anneal is "an obvious drawback involving time and energy." *Id.* at col. 2, lines 48-50. Thompson further characterizes methods employing a non-recrystallizing final anneal as "unduly sensitive to time and temperature, and [] thus most difficult to control." Id. at col. 2, lines 41-48. Thus, Thompson relies on a different principle for achieving a product that resists the formation of flow lines than that the principle employed by the method of claim 4. Further, Thompson criticizes methods including a final non-recrystallizing anneal, such as that employed by the method of claim 4.

Neutjens also employs a different principle than that employed by the method of claim 4. Neutjens does not employ the principle of recrystallizing as much as possible on an intermediate anneal as opposed to a final anneal. Instead, Neutjens teaches that the intermediate anneal should preferably be completely omitted, meaning that any and all recrystallization would take place on the final anneal. *See* Neutjens at page 3, lines 52-55.

As explained above, both Neutjens and Thompson employ a principle of recrystallization solely on a final anneal, which is inconsistent with the principle of primarily recrystallizing on an intermediate anneal with little recrystallization on a final anneal that is employed by claim 4. Accordingly, one of ordinary skill in the art would not

combine Neutjens and Thompson in the manner proposed in the Office Action, which would violate the principle taught and employed by Neutjens and Thompson. As such, the teachings of Neutjens and Thompson cannot sustain even a *prima fascia* case of obviousness. *See* MPEP at § 2143.01 (VI).

Further, the Office Action's justification for combining Neutjens and Thompson is based on the incorrect premise that flattening is the same as stretch-forming. The Office Action alleges that Neutjens' remark regarding "light post treatment such as flattening" discloses stretch-forming, and alleges that one of ordinary skill in the art would apply Thompson's teaching regarding stretching to Neutjen's method to achieve flattening. *See* Office Action, pages 4 and 7. These statements are based on the Office Action's incorrect assertion that "[f]lattening can also be considered stretching (elongation), since the dimension [sic] of a flattened product are larger by a certain percentage than the dimensions of a product before flattening." *Id.* at 4. In fact, one or ordinary skill in the art would know that flattening involves a compressive force (e.g., a pressing force) applied to the face of an object, such as a sheet, as opposed to stretching which involves applying tensile force (e.g., a pulling force) to ends of a sheet. As noted in a scientific and technical dictionary, flattening is "[a]lso known as compression." *See* appendix, **McGraw-Hill Dictionary of Scientific and Technical Terms**, 6th ed., 2003 at 817. Further, flattening need not cause any overall change in thickness of the sheet. *See id.* (including a mechanical engineering definition of flattening as "[s]traightening of a metal sheet by passing it through special rollers with flatten it without changing its thickness.")

One of ordinary skill in the art would recognize that flattening and stretch-forming are <u>different processes</u> that subject a semi-finished product to different types of forces and can have different effects on the microstructure of objects. Thus, one of ordinary skill in the art would not have found it obvious to substitute stretch forming in a process where flattening is desired.

Dunbar and Thompson

With respect to Dunbar and Thompson, the Office Action alleges that Dunbar discloses all limitations of claim 4, except that the semi-finished product is stretch-formed by 0.1 to 0.5% after final soft annealing. The Office Action relies on Thompson to teach stretching a semi-finished product by 0.1 to 0.5%. The Office Action further alleges that it would have been obvious to modify the process of Dunbar to include the stretching step of Thompson because Dunbar would have the "motivation to perform such a process to achieve the benefits of a flattened Al-Mg sheet." *See* Office Action, page 7.

Applicants respectfully disagree. The invention of claim 4 is not obvious, at least, because the combination of the teachings Dunbar and Thompson proposed by the Office Action is improper. The Office Action failed to consider each of Dunbar and Thompson in its entirety, including portions of those references that teach away from the proposed combination. Further, the combination relies on an underlying principle different that that employed by Dunbar or Thompson. Finally, the Office Action's justification for combining the references is based on an incorrect premise.

As explained above, Thompson employs continuous annealing furnaces and teaches against the use of batch annealing furnaces. A combination that employs annealing in a batch furnace, as required by claim 4, contradicts the teaching of Thompson, which explicitly requires continuous annealing.

Further, Thompson teaches away from any combination that includes a final cold rolling pass in which a degree of deformation is limited to not more than 30%, as required by claim 4. The Office Action notes that Dunbar discloses a final cold rolling that produces a sheet having a thickness from 20 to 80% of the intermediate sheet, and alleges that it would have been obvious to select "any portion of the claimed ranges of alloying components and processing parameters," citing MPEP §. 2144.05. *See* Office Action pages 5, 7-8. However, this assertion ignores Thompson's teaching as a whole, which requires a reduction in thickness of at least 40% on a final cold rolling pass.

Additionally, one of ordinary skill in the art would not have had any reason to combine the teachings of Dunbar and Thompson in the manner proposed by the Office Action. Unlike Thompson, which is directed to a method of producing a sheet resistant to the formation of flow lines, Dunbar includes no teaching regarding flow lines. Instead, Dunbar is directed to producing aluminum sheets with a fine grain size to achieve high ultimate tensile strength. (*See* Dunbar at col. 2, lines 24-32.) The Office Action's assertion that one of ordinary skill in the art would be motivated to add a final stretch-forming step on to the method of Dunbar to achieve the benefits of a flattened sheet is based on a misunderstanding of stretch-forming. As explained above, stretch-forming is not the same as, and is not equivalent to, "flattening." Contrary to the Office Action's assertion, there would be no reason for one of ordinary skill in the art to add a "stretch-forming" step onto the method of Dunbar.

Because it would not have been obvious to combine the teachings of Neutjens and Thompson, or the teachings of Dunbar and Thompson, in the manner suggested by the Office Action to produce the Applicants' claimed invention, the rejection of claim 4 is improper. Accordingly, Applicants respectfully request reconsideration and withdrawal of the rejection of claim 4.

NEW CLAIMS 5 & 6

Applicants respectfully submit that new claims 5 and 6 are patentable over any combination of Neutjens, Thompson and Dunbar, at least because claim 5 depends from allowable independent claim 4 and independent claim 6 incorporates the patentable elements of claim 4. Claims 5 and 6 also include the limitation that the method does not include soft annealing in a continuous annealing furnace or quenching between the first cold roll pass and stretch-forming, which is not taught or suggested by any combination of the cited references.

CONCLUSION

In view of the foregoing, it is respectfully submitted that this application is now in condition for allowance. For the reasons detailed herein, Applicants respectfully request that the rejection be reconsidered and withdrawn, and that the claim be passed into allowance. Should the Examiner have any questions, comments, or suggestions in furtherance of the prosecution of this application, the Examiner is invited to contact Applicants' representative by telephone at the number indicated below.

Respectfully submitted,

Date: June 29, 2010
Reg. No.: 61,189
Tel. No.: (617) 526-9727
Fax No.: (617) 526-9899

/Anita M. Bowles, 61,189/
Anita M. Bowles, Ph.D.
Agent for the Applicant(s)
Proskauer Rose LLP
One International Place
Boston, MA 02110-2600

Appendix

McGRAW-HILL DICTIONARY OF SCIENTIFIC AND TECHNICAL TERMS

Sixth Edition

McGraw-Hill
New York Chicago San Francisco
Lisbon London Madrid Mexico City
Milan New Delhi San Juan Seoul Singapore Sydney Toronto

On the cover: Representation of a fullerene molecule with a noble gas atom trapped inside. At the Permian-Triassic sedimentary boundary the noble gases helium and argon have been found trapped inside fullerenes. They exhibit isotope ratios quite similar to those found in meterorites, suggesting that a fireball meteorite or asteroid exploded when it hit the Earth, causing major changes in the environment. *(Image copyright © Dr. Luann Becker. Reproduced with permission.)*

Over the six editions of the Dictionary, material has been drawn from the following references: G. M. Garrity et al., *Taxonomic Outline of the Procaryotes,* Release 2, Springer-Verlag, January 2002; D. W. Linzey, *Vertebrate Biology,* McGraw-Hill, 2001; J. A. Pechenik, *Biology of the Invertebrates,* 4th ed., McGraw-Hill, 2000; *U.S. Air Force Glossary of Standardized Terms,* AF Manual 11-1, vol. 1, 1972; F. Casey, ed., *Compilation of Terms in Information Sciences Technology,* Federal Council for Science and Technology, 1970; *Communications-Electronics Terminology,* AF Manual 11-1, vol. 3, 1970; P. W. Thrush, comp. and ed., *A Dictionary of Mining, Mineral, and Related Terms,* Bureau of Mines, 1968; *A DOD Glossary of Mapping, Charting and Geodetic Terms,* Department of Defense, 1967; J. M. Gilliland, *Solar-Terrestrial Physics: A Glossary of Terms and Abbreviations,* Royal Aircraft Establishment Technical Report 67158, 1967; W. H. Allen, ed., *Dictionary of Technical Terms for Aerospace Use,* National Aeronautics and Space Administration, 1965; *Glossary of Stinfo Terminology,* Office of Aerospace Research, U.S. Air Force, 1963; *Naval Dictionary of Electronic, Technical, and Imperative Terms,* Bureau of Naval Personnel, 1962; R. E. Huschke, *Glossary of Meteorology,* American Meteorological Society, 1959; *ADP Glossary,* Department of the Navy, NAVSO P-3097; *Glossary of Air Traffic Control Terms,* Federal Aviation Agency; *A Glossary of Range Terminology, White Sands Missile Range, New Mexico,* National Bureau of Standards, AD 467-424; *Nuclear Terms: A Glossary,* 2d ed., Atomic Energy Commission.

McGRAW-HILL DICTIONARY OF SCIENTIFIC AND TECHNICAL TERMS,
Sixth Edition

1 2 3 4 5 6 7 8 9 0   DOW/DOW   0 8 7 6 5 4 3 2

ISBN 0-07-042313-X

Library of Congress Cataloging-in-Publication Data

McGraw-Hill dictionary of scientific and technical terms--6th ed.
p. cm.
ISBN 0-07-042313-X (alk. paper)
1. Science--Dictionaries. 2. Technology--Dictionaries. I. Title: Dictionary of scientific and technical terms.

Q123.M15 2002
503—dc21 2002026436

flat-nose bit *See* flat-face bit. { 'flat ,nōz ,bit }

flat of bottom [NAV ARCH] That portion of a ship's bottom without rise or having a rise with little or no curvature. { 'flat əv 'bäd·əm }

flatpack [ELECTR] Semiconductor network encapsulated in a thin, rectangular package, with the necessary connecting leads projecting from the edges of the unit. { 'flat,pak }

flat-panel display *See* panel display. { 'flat ¦pan·əl di'splā }

flat-plate collector [ENG] A solar collector consisting of a shallow metal box covered by a transparent lid. { 'flat ¦plāt kə'lek·tər }

flat-position welding [MET] Welding above the joint with the face of the weld in the horizontal reference plane. Also known as downhand welding. { 'flat pə,zish·ən 'weld·iŋ }

flat roof [ARCH] A roof pitched only enough to allow water to drain off. { ¦flat ¦rüf }

flat rope [DES ENG] A steel or fiber rope having a flat cross section and composed of a number of loosely twisted ropes placed side by side, the lay of the adjacent strands being in opposite directions to secure uniformity in wear and to prevent twisting during winding. { ¦flat ¦rōp }

flats [GRAPHICS] Stage constructions, used in series, to produce a painted background, usually architectural details; they are canvas-covered frames and are used for all flat surfaces on the stage, such as room interiors or exterior walls of buildings. { flats }

flat slab [CIV ENG] A flat plate of reinforced concrete designed to span in two directions. { ¦flat ¦slab }

flat space [MATH] A Riemannian space for which a coordinate system exists such that the components of the metric tensor are constants throughout the space; equivalently, a space in which the Riemann-Christoffel tensor vanishes throughout the space. { ¦flat ,spās }

flat space-time [RELAT] Space-time in which the Riemann-Christoffel tensor vanishes; geometry is then equivalent to that of the Minkowski universe used in special relativity. { 'flat ¦spās ¦tīm }

flat spin [MECH] Motion of a projectile with a slow spin and a very large angle of yaw, happening most frequently in fin-stabilized projectiles with some spin-producing moment, when the period of revolution of the projectile coincides with the period of its oscillation; sometimes observed in bombs and in unstable spinning projectiles. { ¦flat 'spin }

flat spring *See* leaf spring. { ¦flat ¦spriŋ }

flattening [GEOD] The ratio of the difference between the equatorial and polar radii of the earth; the flattening of the earth is the ellipticity of the spheroid; the magnitude of the flattening is sometimes expressed as the numerical value of the reciprocal of the flattening. Also known as compression. [MET] Straightening of metal sheet by passing it through special rollers which flatten it without changing its thickness. Also known as roll flattening. { 'flat·ən·iŋ }

flattening test [MET] Quality test performed by flattening metal tubing between parallel plates that are a specified distance from each other. { 'flat·ən·iŋ ,test }

flatting agent [MATER] Additive substance for paints or varnishes to disperse incident light rays to give the dried surface a nonglossy matte finish. { 'flat·ən·iŋ ,ā·jənt }

flat-top antenna [ELECTROMAG] An antenna having two or more lengths of wire parallel to each other and in a plane parallel to the ground, each fed at or near its midpoint. { 'flat ,täp an,ten·ə }

flat-top boom [ACOUS] A sonic boom whose pressure signature is shaped to reduce the perceived amplitude of the shocks by allowing plateaus following the bow shock and preceding the tail shock. { ¦flat ¦täp 'büm }

flat-top response *See* band-pass response. { 'flat ¦täp ri'späns }

flat trajectory [MECH] A trajectory which is relatively flat, that is, described by a projectile of relatively high velocity. { ¦flat trə'jek·trē }

flat tuning [ELECTR] Tuning of a radio receiver in which a change in frequency of the received waves produces only a small change in the current in the tuning apparatus. { ¦flat 'tün·iŋ }

flat-turret lathe [MECH ENG] A lathe with a low, flat turret on a power-fed cross-sliding headstock. { 'flat ,tə·rət 'lāth }

flatulence [MED] Excessive intestinal gas. { 'flach·ə·ləns }

flatus [MED] Gas in the intestinal tract. { 'flād·əs }

flatwood [ECOL] An almost-level zone containing mostly imperfectly drained, acid soils and vegetation consisting of wiregrass and saw palmetto at ground level, shrubs such as gallberry and waxmyrtle, and trees such as longleaf and slash pines. { 'flat,wu̇d }

flatworm [INV ZOO] The common name for members of the phylum Platyhelminthes; individuals are dorsoventrally flattened. { 'flat,wərm }

flat yard [CIV ENG] A switchyard in which railroad cars are moved by locomotives, not by gravity. { 'flat ,yärd }

flavan [BIOCHEM] $C_{15}H_{14}O$ 2-Phenylbenzopyran, an aromatic heterocyclic compound from which all flavonoids are derived. { 'fla·vən }

flavanol [BIOCHEM] Yellow needles with a melting point of 169°C, derived from flavanone; a flavanoid pigment used as a dye. Also known as 3-hydroxyflavone. { 'fla·və,nȯl }

flavanone [BIOCHEM] $C_{15}H_{12}O_2$ A colorless crystalline ketone, that often occurs in plants in the form of a glycoside. { 'fla·və,nōn }

flavescence [PL PATH] Yellowing or blanching of green plant parts due to diminution of chlorophyll accompanying certain virus disease. { flə'ves·əns }

flavin [BIOCHEM] Any of several water-soluble yellow pigments occurring as coenzymes of flavoproteins. { 'fla·vən }

flavin adenine dinucleotide [BIOCHEM] $C_{27}H_{33}N_9O_{15}P_2$ A coenzyme that functions as a hydrogen acceptor in aerobic dehydrogenases (flavoproteins). Abbreviated FAD. { 'fla·vən 'ad·ən,ēn dī'nü·klē·ə,tīd }

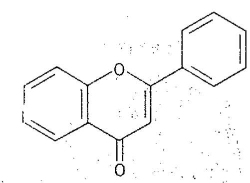
flavin mononucleotide *See* riboflavin 5′-phosphate. { 'fla·vən ¦mä·nō'nü·klē·ə,tīd }

flavin phosphate *See* riboflavin 5′-phosphate. { 'fla·vən 'fäs,fāt }

Flavobacterium [MICROBIO] A genus of bacterium of uncertain affiliation; gram-negative coccobacilli or slender rods producing pigmented (yellow, red, orange, or brown) growth on solid media. { ¦fla·vō·bak'tir·ē·əm }

flavone [BIOCHEM] **1.** Any of a number of ketones composing a class of flavonoid compounds. **2.** $C_{15}H_{10}O_2$ A colorless crystalline compound occurring as dust on the surface of many primrose plants. { 'fla,vōn }

FLAVONE



Structural formula of flavone.

flavonoid [BIOCHEM] Any of a series of widely distributed plant constituents related to the aromatic heterocyclic skeleton of flavan. { 'fla·və,nȯid }

flavonol [BIOCHEM] **1.** Any of a class of flavonoid compounds that are hydroxy derivatives of flavone. **2.** $C_{16}H_{10}O_2$ A colorless, crystalline compound from which many yellow plant pigments are derived. { 'fla·və,nȯl }

flavoprotein [BIOCHEM] Any of a number of conjugated protein dehydrogenases containing flavin that play a role in biological oxidations in both plants and animals; a yellow enzyme. { ¦fla·vō¦prō,tēn }

flavor [FOOD ENG] The set of characteristics of a food that causes a simultaneous reaction or sensation of taste on the tongue and odor in the olfactory center in the nose. [PART PHYS] A label used to distinguish different types of leptons (the electron, electron neutrino, muon, muon neutrino, and possibly others) and different color triplets of quarks (the up, down, strange, and charmed quarks, and possibly others). { 'flā·vər }

flavor enhancer [FOOD ENG] A substance that accentuates the taste of a food to which it has been added without contributing a flavor of its own. Also known as potentiator. { 'flā·vər in,han·sər }

flaw [MATER] A discontinuity in a material beyond acceptable established limits. [METEOROL] An English nautical term for a sudden gust or squall of wind. [MINERAL] A faulty part of a gemstone, such as a crack, visible imperfect crystallization, or internal twinning or cleavage. [OCEANOGR] **1.** The seaward edge of fast ice. **2.** A shore lead just outside fast ice. { flȯ }

flax [BOT] *Linum usitatissimum.* An erect annual plant with linear leaves and blue flowers; cultivated as a source of flaxseed and fiber. { flaks }

flax rust [PL PATH] A disease of flax caused by the rust fungus *Melampsora lini.* { 'flaks ,rəst }

flaxseed [BOT] The seed obtained from the seed flax plant; a source of linseed oil. Also known as linseed. { 'flak,sēd }

PLANAR, ROLLED SEMI-FINISHED PRODUCT MADE OF ALUMINUM ALLOYS

CROSS-REFERENCE TO RELATED APPLICATIONS

[001] This application is a National Phase Application of International Application No. PCT/EP2004/003397, filed on March 31, 2004, which claims the benefit of and priority to European Patent Application No. 03 008 147.5 filed April 8, 2003. The disclosures of the above applications are incorporated herein by reference in their entirety.

TECHNICAL FIELD~~BACKGROUND~~ OF THE INVENTION

The invention relates to a planar, rolled semi-finished product made of one or more aluminum alloys, such as aluminum strips or sheets for further processing by means of deforming or deep drawing (e.g., for the production of sheet metal for car bodies for the automobile industry), and methods of making such products. More specifically, the invention relates to a planar, rolled semi-finished product made of one or more aluminum alloys, wherein the aluminum alloys have the following alloy proportions in weight-%:

$2 \leq Mg \leq 5$;

$Mn \leq 0.5$;

$Cr \leq 0.35$;

$Si \leq 0.4$;

$Fe \leq 0.4$;

$Cu \leq 0.3$;

$Zn \leq 0.3$;

$Ti \leq 0.15$ and

others at a sum of a maximum of 0.15, individually at a maximum of 0.05, residual Al, wherein the semi-finished product has been rolled off of an ingot, and during the rolling process has been subjected to at least one intermediate soft annealing between two cold roll passes and one final soft annealing, each in a batch furnace, as well as a method for the production of such a planar, rolled semi-finished product.

[002] These planar, rolled semi-finished products are aluminum strips or sheets for the further processing by means of deforming or deep drawing, for example for the production of sheet metal for car bodies for the automobile industry.

BACKGROUND

[003] It *is* known that standard alloys, such as AA5052, AA5754 , or AA5182, which have alloy proportions as specified above~~in the stated areas~~, have a tendency to form stretcher strains, particularly flow lines, during deep drawing.

[004] Such stretcher strains are highly undesirable for high demands of the surface of exterior car body parts, as they are still visible after painting.

[005] Moreover, various approaches are known from prior art, which result in the reduction or the complete avoidance of the undesired flow lines after deforming and deep drawing, respectively. These include in particular the addition of Zn and/or Cu, the omission of the intermediate soft annealing, and/or the final soft annealing in the continuous furnace. The setting of the grain size by means of the addition of Zn and/or Cu leads to the increased risk of creating a so-called orange skin during the deforming and the deep drawing, respectively. If the intermediate soft annealing is omitted, increased demands are created of the cold roll process or of the preliminary warm roll process, since the reductions per pass are limited with cold rolling. Finally, the use of a continuous furnace involves high initial purchase costs.

[006] Furthermore, for avoiding flow lines during the deforming or deep drawing of semi-finished products, a method for the production of semi-finished products is known from US P~~p~~atent ~~specification~~ No. 4,151,013, in which an ingot made of aluminum alloys is cold rolled into a semi-finished product directly after the hot rolling, or after an intermediate soft annealing at a reduction of thickness of at least 40%, mostly 60% - 80%, the semi-finished product is then subjected to a final soft annealing in a continuous furnace, and is finally stretch-formed by 0.25% to 1%. It has been shown, however, that semifinished products produced by means of the known method do not safely avoid flow lines, for example during subsequent deep drawing.

SUMMARY OF THE INVENTION

[007] Based on the previously described prior art, the present invention is based on the task of providing a planar, rolled semi-finished product made of aluminum alloys, and a method for the production of such a planar, rolled semi-finished product, respectively, which enables the use of standard alloys without the addition of Zn and Cu or other elements, can do without any extensive production lines, and ensures improved process safety with regard to deep drawn or deformed end products being free of flow lines.

[008] The previously derived and shown task is solved in accordance with the first teaching of the invention in that the degree of deformation before the first intermediate soft annealing is at least 50%, and before the final soft annealing not more than 30%, and that the semi-finished product has been stretch-formed by 0.1 to 0.5% after the final soft annealing.

[009] Initially, a rough structure is created in the semifinished product by means of a high degree of deformation of at least 50% before the first intermediate annealing so that the recrystallization temperature of the aluminum alloy is reduced, and a recrystallization of the semifinished product, which is as complete as possible, occurs during the intermediate annealing. With the subsequent cold rolling at a maximum degree of deformation of 30%, only few surface defects are incorporated into the soft, recrystallized semi-finished product so that the semi-finished product having a fine-grained structure is conveyed to the final soft annealing. The combination of the previous processing steps with the final stretch-forming and the properties of the alloy surprisingly ensure that no flow lines appear during the deforming or deep drawing of the semifinished product. Furthermore, the semi-finished product according to the invention has a long shelf life of several years, during which the properties do not substantially change. In particular, it is not necessary to set a specific grain size so that the risk of the occurrence of an orange-peel skin is not present with the deforming. ~~:~~ Therefore, a product free of flow lines may also be obtained at grain sizes of below 50 µm. Finally, no soft or solution annealing is necessary in the continuous furnace with subsequent quenching. In summary it can be concluded that the finishing process for the production of the planar, rolled semi-finished product according to the invention has great robustness.

[010] An advantageous embodiment of the planar, rolled semifinished product according to the invention is that the semi-finished product has been stretch-formed after the final soft annealing by 0.2 to 0.5%. The stretch-forming by at least 0.2% further increases the process safety with the production of the semi-finished product according to the invention.

[011] The stretch-forming of the planar, rolled semi-finished product may be performed in various manners. For example, the stretch-forming in a strip stretch-forming line, but also the stretch-forming with the assistance of the alternating turning around of the strip or the sheet on a so-called leveling line, in which the strip is stretch-formed to the exterior radius at each turn and is compressed at the interior radius.

[012] If the semi-finished product has a coating that has been applied in retrospect using the coil coating process, the deformability of the semi-finished product in the subsequent deforming or deep drawing steps can thus be improved by means of the associated heat treatment, without adversely affecting the lack of flow lines. According to a second teaching of the invention, the previously derived and shown task is solved by means of a method for the production of a planar, rolled semifinished product made of aluminum alloys, in which the semi-finished product is rolled off of an ingot containing the above stated alloy proportions, during the rolling process is subjected to at least one intermediate soft annealing between two cold roll passes and one final soft annealing, each in a batch furnace, wherein the degree of deformation before the first intermediate soft annealing is at least 50%, and before the final soft annealing is not more than 30%, and the semi-finished product is stretch-formed after the final soft annealing by 0.1 to 0.5%.

[013] As explained above, the semi-finished product produced in accordance with the method according to the invention has a further improved process safety with regard to avoiding flow lines during the subsequent deforming or deep drawing of the semi-finished product.

~~[012]~~ There is a multitude of possibilities to develop and further embody the planar, rolled semi-finished product according to the first teaching of the invention and the method for the production of such a planar, rolled semifinished product according to the second teaching of the invention respectively. For this purpose, reference is made, ~~for instance to the patent claim~~

~~subordinate to patent claim one, on one hand, as well as~~ to the following description in combination with the drawing~~, on the other hand~~.

[0014]

BRIEF DESCRIPTION OF THE DRAWING

~~[0014]~~ The drawing shows the only figure of an embodiment of a line for the production of a planar, rolled semi-finished product made of aluminum alloys according to the first teaching of the invention and for realizing a method for the production of such a planar, rolled semi-finished product according to the second teaching of the invention, respectively.

[0015]

DETAILED DESCRIPTION OF THE INVENTION

[0016] The embodiment of the line for the production of a planar, rolled semi-finished product made of aluminum alloys according to the invention, in particular of a semi-finished product for the production of sheet metal for car bodies, has a hot roll line 1 with a reversing frame 2, and an optional subsequent, multilevel hot roll frame 3. In this hot roll line 1 an ingot 4, for example made of a standard alloy, such as AA5052, AA5754, or AA5182, is rolled off and subsequently reeled into a coil 5 on a reeling station. After cooling of the coil 5, the strip is subjected on a first cold roll line 6 to one or more cold roll passes, wherein the degree of deformation is at least 50% for the reducing of the recrystallization temperature of the strip.

[0017] In the exemplary embodiment illustrated, the cold rolled, newly reeled strip is soft annealed in a batch furnace 7 in an intermediate process. During the intermediate soft annealing, the relatively rough structure of the strip recrystallizes nearly completely so that the strip is present in a soft and recrystallized state after the intermediate annealing.

[0018] Subsequently, the intermediately soft annealed strip is again subjected to cold rolling on a second cold roll line 8 at a degree of deformation of not more than 30%. With this measure, only a low amount of surface defects is created in the strip so that the strip has a fine-grained structure after the last cold roll process.

[019] Subsequent of the last cold roll pass, the newly reeled strip is subjected to a final soft annealing in a second batch furnace 9. Subsequently, the cooled strip is stretch-formed by 0.1 to 0.5% on a so-called leveling line 10.

[020] Instead of the leveling line 10, a strip stretch-forming line may also be used, on which the strip is stretchformed across its entire cross-section.

ABSTRACT

[0021] ~~The invention related to a~~ A flat, rolled semi-finished product made of an aluminum alloy and a method of producing the product are disclosed. The aluminum alloys has the following alloy proportions in weight percentages: $2 \leq Mg \leq 5$, $Mn \leq 0.5$, $Cr \leq 0.35$, $Si \leq 0.4$, $Fe \leq 0.4$, $Cu \leq 0.3$, $Zn \leq 0.3$, $Ti \leq 0.15$, other elements totaling no more than 0.15 and separately not exceeding 0.05, and the remainder consists of Al. The semifinished product is rolled from a bar ~~(4)~~and, during the rolling process, is subjected to at least one intermediate tempering between two cold reduction passes and to a final soft-annealing in a chamber furnace~~(7, 9)~~. ~~The invention also relates to a method for producing said semi-finished product.~~ A semi-finished product of this type does not have any flow lines after shaping or deep-drawing if~~, according to the invention,~~ the degree of reshaping before the first intermediate tempering is equal to at least 50% ~~and~~, the degree of reshaping before the final soft-annealing~~,~~ is no greater than 30%, and the semifinished product is drawn by 0.1 to 0.5% after the final soft-annealing.